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Using paleomagnetism to unravel the mysteries of the Summit Creek Basalts

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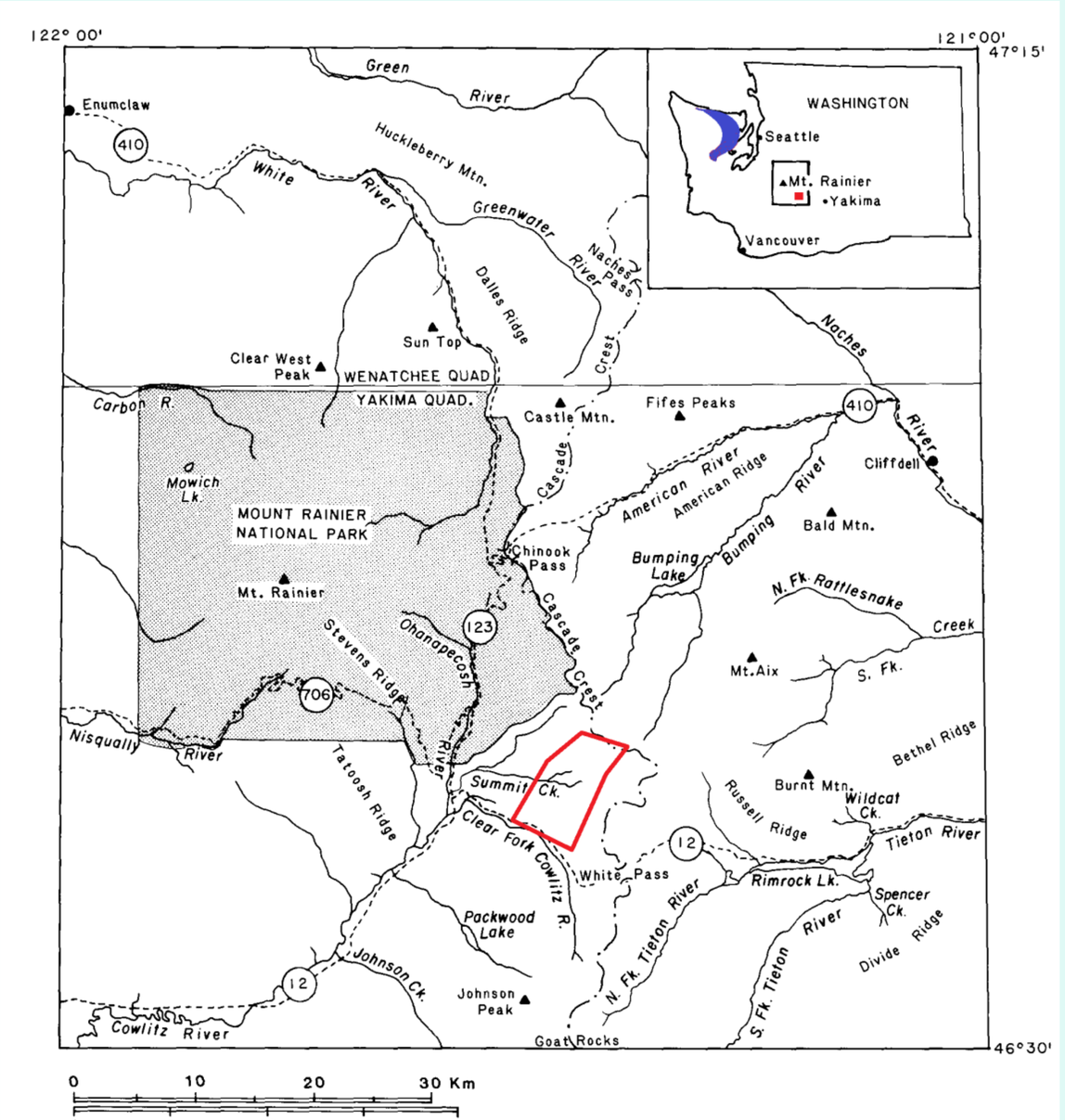
Abstract

The Summit Creek Basalts are a group of poorly understood lava flows located near Washington's Mount Rainier that erupted during the late Eocene. A paleomagnetic survey was conducted to provide evidence for any rotation that has occurred since the flows erupted and determine if the basalts are related to a sequence of flows on the Olympic Peninsula. Additional structural data was mapped to further investigate movement of the unit. Results indicate that the flows have been tilted an average of around 50 degrees and rotated about 45 degrees west of north.



Regional map of Mount Rainier National Park. The Summit Creek Basalts are indicated in red near Highway 12 and in the inset; the basalts of the Crescent Formation are indicated in blue.

Research Questions

- Are the Summit Creek Basalts related to the Crescent Formation?
- Did they erupt *in situ* or were they moved westward to their present location?

Fieldwork

Four trips were made into the field to collect cores and orientation data – two along Hwy 12 and two on Carlton Ridge. Fifteen flows were sampled, with eight to ten drill cores collected from each. Structural flow orientations were mapped based on vesicle horizons and visible flow tops at 21 outcrops along both Hwy 12 and Carlton Ridge.

Drill holes on Carlton Ridge

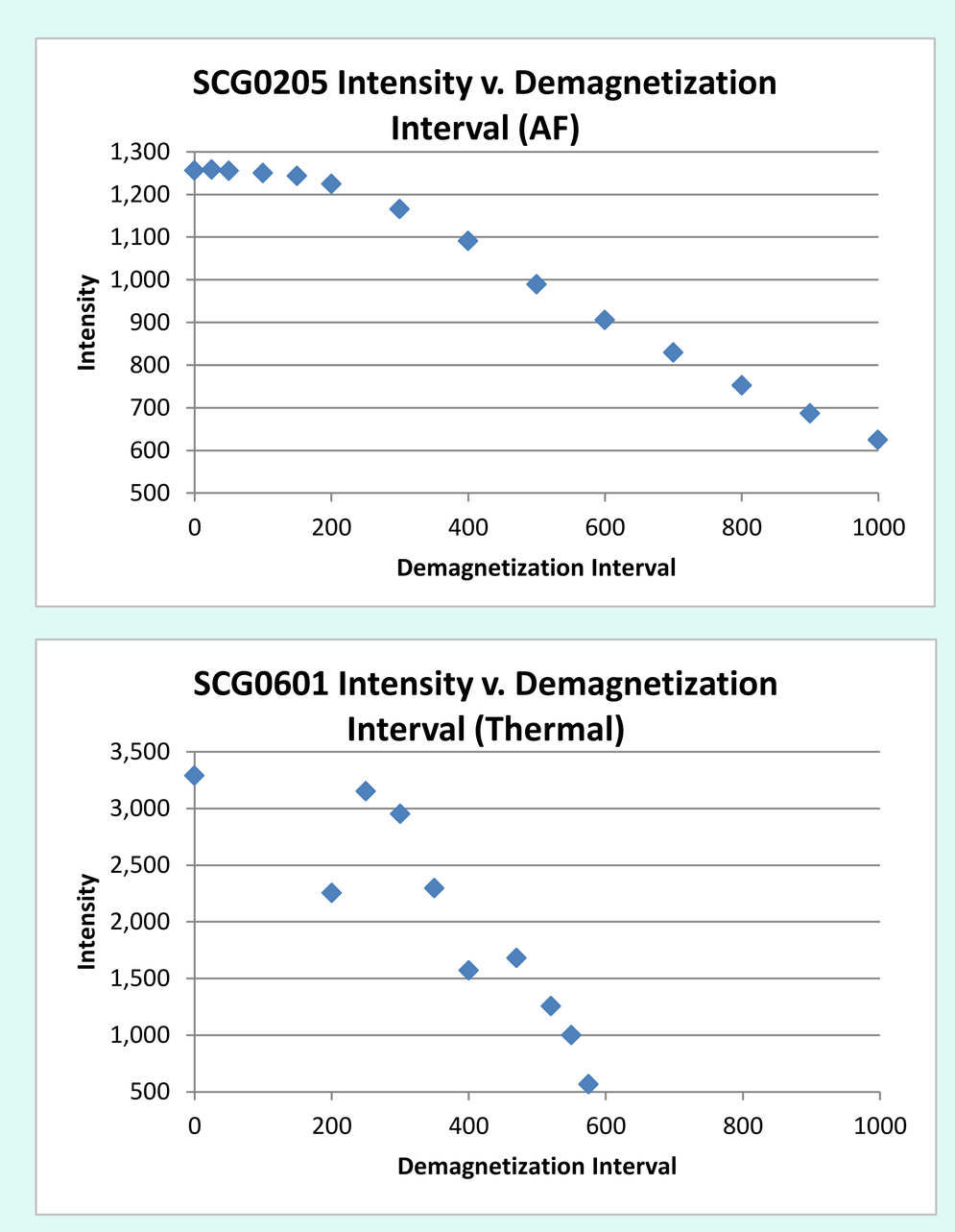
Drilling along Hwy 12

Orienting a drill core

Lab Work and Data

The samples were analyzed with a Molspin magnetometer and demagnetized by intervals using alternating field (AF) and thermal demagnetization to remove any secondary magnetic field overprint. This analysis produces values for the declination and inclination of the magnetic field present when the basalts erupted. Average inclinations and declinations were found for each flow, corrected for core position and flow tilt, and compared to a standard north direction of 0° to determine rotation.

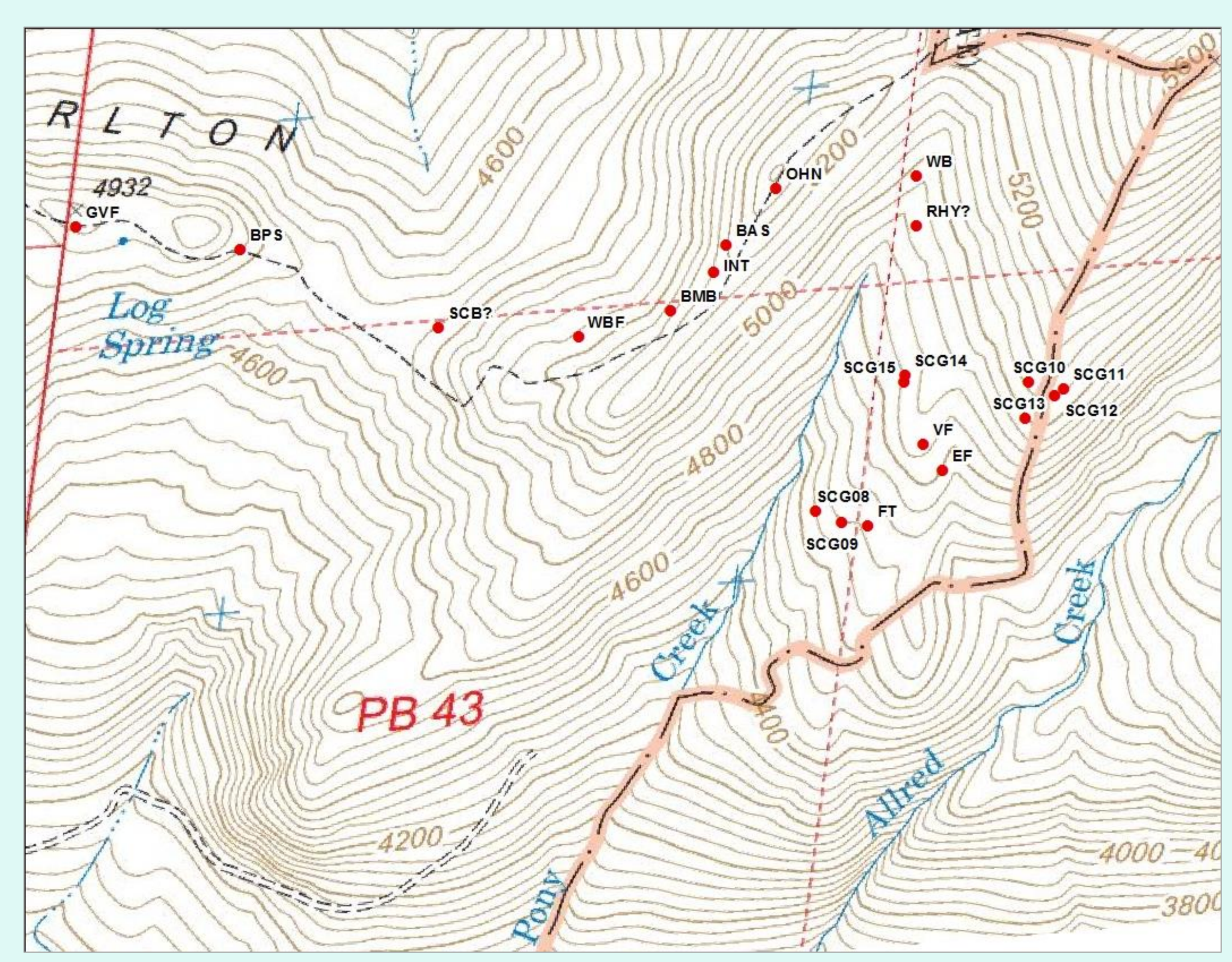
The flow orientations were grouped by location and plotted on stereonet diagrams (below) to help visualize patterns and dominate orientations.



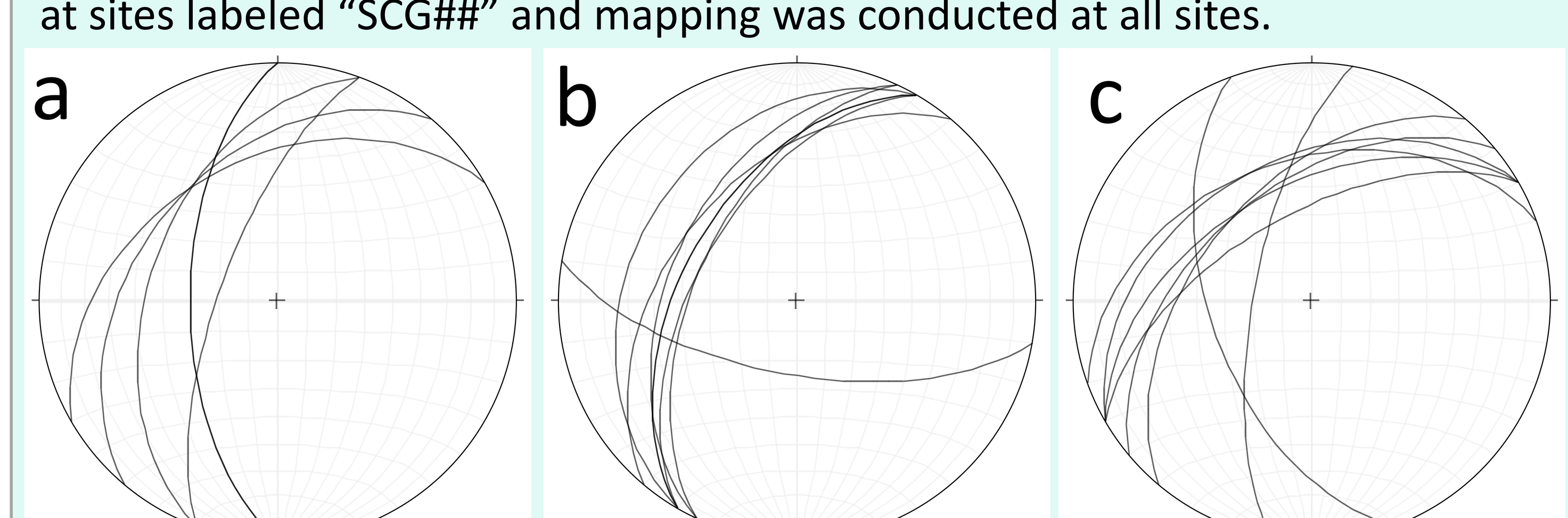
Intensity graphs for two samples showing contrast between AF and thermal demagnetization.

In the first diagram, the intensity of the magnetic field decreases slowly initially as conflicting overprints are removed through, then continues in a more linear progression.

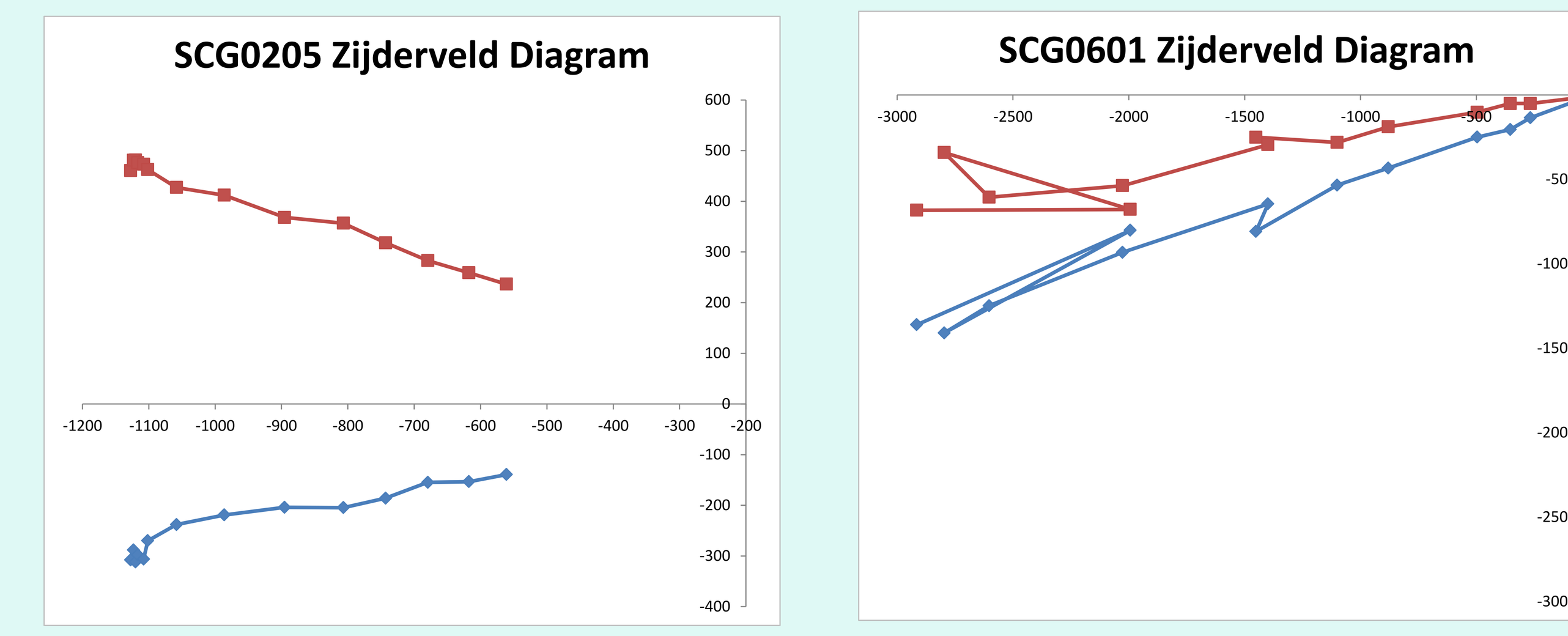
In the second diagram, the intensity drops radically at certain temperatures as the principle magnetic minerals reach their curie temperature and are "cooked" out.



Sample and mapping locations along Carlton Ridge. Drill cores were collected at sites labeled "SCG##" and mapping was conducted at all sites.



Stereonets of flow orientations along (a) the crest of Carlton Ridge; (b) around site SCG10; (c) between sites SCG09 and SCG14. These show that the flows had primarily been deformed into an average orientation with a NE strike and approximately 50° dip.



Zijderveld diagrams are used in the determination of magnetic declination and inclination and show the magnetic field orientation measured by the magnetometer growing closer to its true value as the secondary overprint is removed through demagnetization. On the left, a well-behaved diagram; on the right, a diagram with a less clear progression.

Results and Conclusions

The paleomagnetic results indicate that the flows have rotated counterclockwise to an average of 45 degrees. From these results, we can conclude that the Summit Creek Basalts have been rotated and likely moved in other ways since their eruption. The mapping data confirms that the flows have been deformed by tectonic processes and are no longer in their original, flat-lying state. The variations seen in both strike and dip of the flow orientations also indicates significant deformation. This movement may be related to the extension caused by subduction of the Kula-Farallon slab window beneath the western edge of the North American plate.

References

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